SYNOPSIS OF RESEARCH PROJECT

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6.	**Minor Subject**	:	Agronomy
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8.	**Title of Research Project**	:	**CONSEQUENCE OF HUMIC ACID ON GROWTH, YIELD AND NUTRIENTS UPTAKE BY WHEAT AND SOIL FERTILITY**

9. Introduction

- **Wheat**

  Scientific Name: *Triticum aestivum* L.

  Family: Poaceae

  Chromosome No.: 2n = 42 (Hexaploids)

  Origin: South West Asia (Turkey)

  Common Name: Gehun and Kanak

In India, it is second important staple food crop after rice, which contributes nearly one-third of the total food grains production. Wheat is a grass that is widely grown for its seed, a cereal grain that is a common diet all over the world. The genus *Triticum* is made up of numerous kinds of wheat. Around 9600 BC, according to the archaeological record, wheat cultivation began in the Fertile Crescent. The wheat kernel is a kind of fruit known as a caryopsis in botany. More land is used to grow wheat than any other type of food crop. More wheat is traded globally than all other crops combined. The global production of wheat and other grain crops has tripled since 1960 and it is predicted to continue to increase through the middle of the twenty-first century.

Wheat is a major food for human nutrition and is consumed by billions of people globally, especially in the least developed nations where wheat products are staple foods. In many daily portions containing a variety of foods that satisfy the criteria for whole grain-rich foods, wheat is a healthy food source of numerous nutrients and dietary fibre suggested for children and adults when consumed as the whole grain. The distinctive viscous elastic and sticky properties of gluten proteins, which make it easier to produce processed foodstuffs, are driving up demand for wheat globally. This is because processed foods are becoming more and more popular as a result of global industrialization and the westernization of the diet.

Wheat production during 2023 was 789.50 MT. In which the top producers were China (134.3 MT), India (107.6 MT), Russia (85.9 MT), United States (49.7 MT), Canada (35.2 MT) and France (30.1 MT) (Anon., 2023a). India is divided into 6 major wheat growing zones, namely, Northern Hill Zone, North western Plains Zone, North eastern Plains Zone, Central Zone, Peninsular Zone and Southern Hill Zone. In India Major 5 states in wheat production are Utter Pradesh, Madhya Pradesh, Punjab, Haryana and Rajasthan (Anon., 2023b).

In Gujarat, cultivation of dry wheat in mainly concentrated in Bhal area comprising the parts of Ahmedabad, Bhavnagar, Kheda and Surendranagar district and it is also grown in Vagra, Jambusar and Amod talukas of Bharuch district and in Ghed area of Porbandar district. The dry wheat cultivated in an area of about 0.95 lakh ha with an annual production of 0.48 lakh tones (Anon., 2023c).

Soil organic material is needed up to a satisfactory level for sustainable crop production and high productivity of crops over long periods. Humic Acid (HA), an organic matter, might help to overcome the production constraints of crops with its growth stimulating property. Humic acid is the major component of most of the organic fertilizers and the most active components of soil and compost. Humic acid mainly arises from chemical and biological degradation of plant and animal residues and by the synthetic activities of different micro-organisms. After enrich into the soil it facilitates fertilizer nutrients to reach their maximum potential in improving plant growth. (Swarnali Duary, 2020)

Humic substances consist of three subcategories–humic acids, fulvic acids and humin. Humic acids are considered to be the most abundant naturally occurring organic molecules on earth and are often described as being the most important component of a healthy fertile soil. Approximately 35% of the humic acid’s highly variable structure

is composed of carbon rings with the rest being made up of carbon chains. Humic acids work best in the soil, where they readily unlock nutrients and bind to them, making them available for uptake into plants.

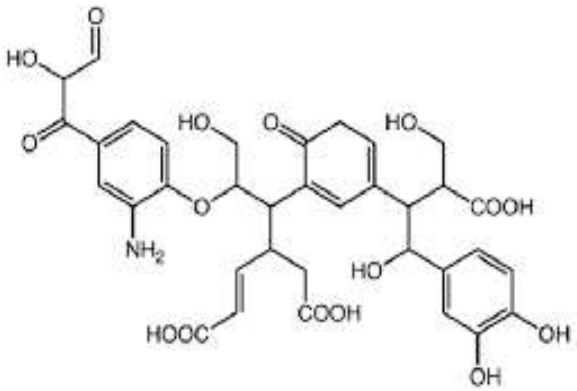

Figure 1. Model structure of humic acid

10. Practical Utility of the Research Project

Recently, among the fertilization strategies, the soil and foliar spray with different molecules as humic acids has been introduced. These organic substances have no harmful threat to the quality of the environment and have excellent beneficial synergy with nutrients and compost (Lee and Bartlett, 1976). Humic substances are subdivided into 3 major fractions, on the basis of solubility of each fraction in water adjusted to different acid, alkaline conditions (Kononova, 1966): Fulvic acid (FA), humic acid (HA) and humus.

Humic acid is not a single compound but is a group of acid radicals found in humic matter. Humic acid comprises a mixture of weak aliphatic and aromatic organic acids which are not soluble in water under acid condition but are soluble in water under alkaline condition. Its molecular weight is very high, ranging from several hundreds to thousands of Dalton (Tan, 2003). Humic acid polymers readily bind clay mineral elements to form stable organic clay complex. Peripheral pores in the polymer are capable of accommodating natural and synthetic organic chemicals in a lattice type arrangement. Humic acid readily forms salts with inorganic trace mineral elements.

The beneficial effects of humic acid appear to be associated with its nutrient-chelating power along with its impact on physico-chemical and biological properties of the soil. Results suggest that addition of humic acid reduce the chemical fertilizer requirements in maize with maximum nutrient accumulation and it may be utilized as

a promising source of cheap organic fertilizer for increasing the crop productivity (Tan and Nopamornbodi, 1979).

The properties of base exchange capacities and complexion ability of humic acid are important in soil stability, transport of metal ions in soil through plant tissues and stabilization of organic matter against microbiological attack. Because of its ability to form complexes it can convert elements into forms suitable for assimilation by plants. Keeping in view the above facts, an experiment entitled **"Consequence of humic acid on growth, yield and nutrients uptake by wheat and soil fertility"** is proposed to undertake at Instructional Farm, College of Agriculture, JAU, Junagadh during *Rabi* season 2025-26 and 2026-27 with following objectives.

11. Objectives

1. To study the effect of humic acid on growth, yield and quality of wheat
2. To study the effect of humic acid on nutrients content and uptake by wheat
3. To assess the effect of humic acid on soil fertility

12. Review of Literature

12.1 Effect of humic acid on growth, yield and quality of wheat

12.1.1 Growth and yield of wheat

Mishra and Srivastava (1988) carried out a field experiment in Bihar. They found that fresh and dry weight yield of 20 days old oats was significantly increased with the application of humic acids at 100 mg on carbon basis over control.

Sathiyabhama *et al*. (2003) conducted a field experiment at Coimbatore to investigate the influence of humic acid and fertilizers on the yield and yield attributes of rice (*Oryza sativa* L.). The findings revealed that the application of humic acid at 20 kg/ha resulted in higher grain and straw yields. However, when humic acid was applied in higher doses (more than 20 kg/ha) along with foliar spray and root dipping, the yield decreased. On the other hand, applying humic acid at 20 kg/ha either alone or in combination with a foliar spray or root dipping of humic acid enhanced the nutrient uptake by rice.

Sao *et al*. (2010) carried out a pot experiment during the winter season of 2004-05 at Anand Agricultural University, Anand, to examine the effect of various levels of FYM and humic acid derived from lignite coal on the yield of fodder maize. The results showed that the application of humic acid at 20 kg/ha proved to be the most effective treatment for improving the dry and green matter yield as well as the root growth of fodder maize.

A field experiment was carried out by Khan *et al.* (2018) at Land Resources Research Institute, National Agricultural Research Centre, Park Road, Islamabad, Pakistan to studied the Effect of humic acid [Plant-derived humic acid (PDHA) and coal-derived humic acid (CDHA)] on growth and crop nutrient status of wheat on two different soils. Data was collected on plant growth parameters such as spike weight, grain and straw weight. Results showed that spike weight increased by 19%, 15%, 26% and 11% with application of PDHA at the rate of 50 and 100 mg/kg in clayey loam and sandy loam soil, respectively. Grain yield show an increase of 21% and 11% over control with application of PDHA and CDHA at the rate of 50 mg/kg on both soils, respectively.

Sundus and Alabdulla (2019) performed an experiment at the College of Agriculture, University of Basrah, Iraq, during the two winter seasons of 2016–17 and 2017–18 on oat. They found that the most effective concentration of humic acid was 6 g/l, which produced the highest green fodder yield (50.6 and 54.4 t/ha), dry fodder yield (16.9 and 18.6 t/ha) and grain yield (6.19 and 5.97 t/ha) in both growing seasons.

Junaid *et al*. (2020) carried out an experiment in Iraq to study the effect of foliar application of humic acid on barley and found that the concentration of 500 mg/l of humic acid resulted in a higher number of spikes (325.6/m²), number of grains (45.42/spike), grain yield (4.98 t/ha), biological yield (8.05 t/ha) and harvest index (38.66%) of barley compared to the control.

Ahmed *et al.* (2024) conducted field experiment on impact of humic acid on growth parameter of wheat under dry climate of Uthal, study revealed that application of humic acid at the rate of 14.5 kg/ha could improve the growth, yield and soil fertility.

Chaitra *et al*. (2024) conducted the experiment at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, to evaluate the impact of soil and foliar application of humic acid derived from vermicompost and a commercial source on the growth and yield parameters of groundnut variety GPBD-4. The results revealed that the treatment involving soil application of humic acid from vermicompost at 20 kg/ha combined with a foliar spray of 0.2% humic acid at 30 DAS recorded the highest plant height (36.83 cm), leaf area index (0.96), higher number of pods/plant (24.00) and pod yield/plant (14.80 g).

Salihi *et al.* (2024) were studied the impacts of humic acid on growth and yield of wheat. Research indicates that humic acid significantly increases wheat plant growth parameters: shoot length (18%), root length (29%), shoot dry weight (76%), root dry

weight (100%) and chlorophyll content (96%). Moreover, humic acid substantially improves wheat yield and yield components, including spike length (14.66%), number of spikes per square meter (28.73%), number o,f spikelet per spike (23.52%) and 1000-grain weight (23.90%).

Vinod *et al.* (2024) conducted experiment at departmental farm of Soil Science and Agricultural Chemistry, College of Agriculture, Latur. The field study indicated that the nutrient uptake and content and grain and straw yield of black gram crop were significantly influenced due to soil and foliar application of humic acid and RDF. They reported that significantaly higher grain and straw yield found due to treatment T_8 (RDF + soil application of humic acid @ 20 kg/ha + foliar application of humic acid @ 0.2% at 20 and 35 DAS) in black gram.

12.1.2 Quality of wheat

Patel (2011) executed an experiment at Anand Agricultural University to compare the effects of organic and inorganic fertilizers with humic acid on the quality of wheat. He observed that the highest protein content (10.99%) in wheat grain was obtained with the application of FYM at 5 t/ha combined with soil application of humic acid at 10 kg/ha and foliar application at 0.1% at 55 DAS.

Kandil *et al*. (2016) performed a field experiment at the Experimental Station Farm of Kalabsho and Zayian District, Faculty of Agriculture, Mansoura University, North Nile Delta, Egypt, during the two consecutive winter seasons of 2013–14 and 2014–15 to examine the effect of foliar application of humic acid, amino acid and their combination under different nitrogen fertilizer levels (166, 214 and 262 kg N/ha) on the grain quality characteristics of three bread wheat cultivars (Shaka 93, Gemiza 9 and Giza 168) grown under newly reclaimed sandy saline soil conditions. They found that foliar spraying with a combination of humic and amino acids produced the highest yield attributes and increased the protein and carbohydrate contents in grains by 10.98% and 78.15%, respectively, compared to the control treatment in both seasons.

Sandeep *et al.* (2017) initiated field experiment at Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan. The study revealed that application of humic acid (1500 ppm) along with two sprays of salicylic acid (1.5 mM) applied to the soil immediately after sowing of groundnut resulted in higher oil content (41.7%) and protein content (26.1%).

Chaitra *et al*. (2024) conducted the experiment at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The results revealed

that the treatment involving soil application of humic acid from vermicompost at 20 kg/ha combined with a foliar spray of 0.2% humic acid at 30 DAS recorded significantly the highest oil content (46.12%), crude protein content (25.38%) and relative chlorophyll content (34.82 SPAD value).

12.2 Effect of humic acid on nutrients content and uptake by wheat

Mishra and Srivastava (1988) carried out a field experiment in Bihar. They reported that humic acids extracted from different soils of Bihar showed a significant effect on nitrogen (N) and phosphorus (P) uptake by oat. The efficiency of humic acid varied between 25% and 65%.

Sharif *et al*. (2002) stated that humic acid has produced encouraging results in enhancing crop yield as an affordable natural fertilizer source. They performed a field experiment at Peshawar, Pakistan, to evaluate the effect of 0.5 and 1.0 kg/ha humic acid applied alone and in combination with full (120 + 90 + 60 kg/ha) and half (60 + 45 + 30 kg/ha) recommended doses of NPK on wheat. The application of 0.5 and 1.0 kg/ha humic acid, both alone and with NPK, increased wheat grain yield by 25 to 69% and total dry matter by 36 to 65% compared to the control. The soil concentrations of Zn, Mn and Cu, as well as the plant accumulation of Fe and Cu were significantly enhanced with the application of humic acid.

Yushma (2005) worked on the effect of humic acid, derived from lignite coal on soil properties and plant growth of fodder maize and concluded that the application of humic acid @ 20 kg/ha recorded maximum uptake of nitrogen (210 mg/pot) as compared to other treatments as humic acid increases the biological activity and thereby increasing translocation of nutrients.

Arjumend *et al.* (2015) conducted experiment on effects of lignite-derived humic acid on some selected soil properties, growth and nutrient uptake of wheat at Jammu kashmir he revealed that increased the NPK uptake by wheat grown under humic acid was 57%, 96% and 62%, respectively over the control.

Khan *et al*. (2014) reported that humic acid application of 25 and 50 mg/kg along with Nitrogen of 150 and 300 mg/kg in maize increased the nitrogen, phosphorus and potassium content (20 and 26, 14 and 20, 10%, respectively). Thus, humic acid application along with nitrogen improved the nutrient uptake of maize obtained from char coal mines.

Saha *et al*. (2014) carried out an experiment at the Central Farm of Bangladesh Agricultural University during the Rabi season to study the effect of humic acid and

poultry manure on nutrient content and their uptake by rice. They reported that the highest nitrogen content in grain and straw (1.38% and 0.89%, respectively) was obtained with the application of humic acid at 6 l/ha, while the lowest nitrogen content (1.29% and 0.44% in grain and straw, respectively) was recorded under the control treatment.

Vinod *et al*. (2024) conducted experiment at departmental farm of Soil Science and Agricultural Chemistry, College of Agriculture, Latur. The field study indicated that the nutrient uptake and content and grain and straw yield of black gram crop were significantly influenced due to soil and foliar application of humic acid and RDF. The uptake of N, P and K were recorded at harvest. Significant and maximum uptake of N, P and K were noticed with application of treatment T_8 (RDF + soil application of humic acid @ 20 kg/ha + foliar application of humic acid @ 0.2% at 20 and 35 DAS).

12.3 Effect of humic acid on soil fertility

The field experiment conducted by Sathiyabhama *et al*. (2003) at Tamilnadu Agriculture University, Coimbatore, Tamil Nadu. He studied the effect of humic acid on nutrient release pattern in an *Alfisol* and found that humic acid was found to contain functional groups that would form the source of negative charge and might contribute towards the CEC soil. A linear trend in the release of N, P and K was observed for the application of humic acid (20 to 80 kg/ha). The release of N was significant up to 20 kg/ha humic acid, whereas for P and K, it extended up to 40 kg/ha humic acid. The N and P were released for a longer period of 60 days, while K release was attained a plateau on 45 days after incubation.

Sangeetha and Singaram (2007) studied the effect of lignite humic acid and fertilizers on the yield and nutrient availability of onion and found significant increase in available N from 105 mg/kg to 119.3 mg/kg and also increase in available K, this might be due to the chelating effect of humic acid.

Arjumend *et al*. (2015) executed an experiment in Jammu and Kashmir to study the effects of lignite-derived humic acid on certain soil properties, as well as on the growth and nutrient uptake of wheat. They found that the application of humic acid enhanced the soil nutrient status by increasing organic matter by 9%, total nitrogen by 30%, available P_2O_5 by 166% and available K_2O by 52%, thereby indicating a significant improvement in soil fertility.

Savita *et al*. (2018) field experiment was conducted at Agronomy field unit, College of Agriculture, Shivamogga to study the effect of humic acid substances on

soybean. Significantly higher available P was recorded due to soil application of humic acid @ 5 kg/ha at sowing + foliar spray of humic acid over the rest of treatments.

Kiran *et al*. (2020) initiated an experiment in the southern dry zone of Karnataka to study the growth and yield of cowpea. They reported that the application of chemical fertilizers along with foliar spraying of humic acid (1000 ppm) and micronutrients on cowpea enhanced the soil nitrogen, P_2O_5, and K_2O status compared to the RDF treatments.

13. Materials and Methods

13.1 Location : Instructional Farm, College of Agriculture, JAU, Junagadh

13.2 Year and season of experiment : *Rabi*, 2025-26 and *Rabi*, 2026-27

13.2.1 Crop and variety : Wheat and GJW 463

13.3 Experimental design

Randomized Block Design (RBD)

13.4 Treatment details

T_1 : 100% RDF (Control)

T_2 : RDF + Soil application of HA 10 kg/ha

T_3 : RDF + Soil application of HA 20 kg/ha

T_4 : RDF + FA of HA 0.5% at 40 and 60 DAS

T_5 : RDF + FA of HA 1% at 40 and 60 DAS

T_6 : RDF + FA of HA 1.5% at 40 and 60 DAS

T_7 : RDF + Soil application of HA 10 kg/ha + FA of HA 0.5% at 40 and 60 DAS

T_8 : RDF + Soil application of HA 20 kg/ha + FA of HA 0.5% at 40 and 60 DAS

T_9 : RDF + Soil application of HA 10 kg/ha + FA of HA 1% at 40 and 60 DAS

T_{10} : RDF + Soil application of HA 20 kg/ha + FA of HA 1% at 40 and 60 DAS

T_{11} : RDF + Soil application of HA 10 kg/ha + FA of HA 1.5% at 40 and 60 DAS

T_{12} : RDF + Soil application of HA 20 kg/ha + FA of HA 1.5% at 40 and 60 DAS

RDF = Recommended dose of fertilizer

Note: 1) 120-60-60 kg/ha N-P_2O_5-K_2O will be applied to all the plots N is applied in two splits 50% at basal and remain 50% at 30 DAS

2) Humic acid source: IFFCO-MC (HUMESTU)

13.5 No. of replications

No. of replications: 3

Total number of plots: 12 × 3 = 36

13.6 Observations to be recorded

13.6.1 Growth parameters

1. Initial and final plant population
2. Plant height (cm) 50 DAS and at harvest
3. Number of total tillers (per m row) (at harvest)

13.6.2 Yield parameters

1. Number of effective tillers (per m row)
2. Length of spike (cm)
3. Number of spikelet per spike
4. Number of grain per spike
5. Grain weight per spike (g)
6. Grain yield (kg/ha)
7. Straw yield (kg/ha)
8. Harvest index (%)

13.6.3 Quality parameters

1. 1000 grain weight (g)
2. Protein content (%) (From grain)

13.6.4 Biochemical parameters

1. Chlorophyll content (SPAD meter) at 45 and 65 DAS and at harvest

13.6.5 Chemical analysis

1. **Soil analysis:** Organic carbon (OC), Available N, P_2O_5, K_2O, S Fe, Mn, Zn and Cu at initial and at harvest

Table 1. Following methodology will be used for the estimation of nutrients in soil

Parameters	Methods	References
Organic Carbon	Wet Oxidation	Walkely and Black's method (1934)
Available nitrogen	Alkaline permanganate method	Subbiah and Asija (1956)
Available phosphorus	Olsen's method Colorimetric, 0.5M NaHCO3 extraction	Olsen *et al*. (1954)
Available potassium	Flame photometric method (Neutral normal NH_4OAc)	Jackson (1974)

Available sulphur	Turbidimetric method	Chaudhary and Cornfield (1966)
Available Micro nutrients (Fe, Mn, Zn and Cu)	DTPA extract method	Lindsay and Norvell (1978)

2. Plant analysis: N, P, K, S, Fe, Mn, Zn and Cu at 45 and 65 DAS and at harvest

Table 2. Following methodology will be used for the estimation of nutrients in plant and seed

Parameters	**Methods**	**References**
Nitrogen	Micro Kjeldahl's digestion method (Diacid digestion with HNO_3: $HClO_4$ in 5:2 ratio)	Kanwar and Chopra (1967)
Phosphorus	Vando-molybdo phosphoric acid yellow colour method (Triacid digestion with HNO_3:H_2SO_4:HlO_4 in 9:2:1)	Jackson (1974)
Potassium	Flame Photometer method (Triacid Extract)	Jackson (1974)
Sulphur	Turbidimetric method	Williams and Steinbers (1959)
Micro nutrients (Fe, Mn, Zn and Cu)	Atomic Absorption Spectrophotometer (AAS)	Jackson (1967)

The uptake of N, P, K and S by biological yield (grain and straw) of wheat will be computed by using the following formula.

$$\text{Macronutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{biological yield (kg/ha)}}{100}$$

The uptake of Fe, Mn, Zn and Cu by biological yield (grain and straw) of wheat to be computed with help of following formula.

$$\text{Micronutrient uptake (g/ha)} = \frac{\text{Nutrient content (mg/kg)} \times \text{biological yield (kg/ha)}}{1000}$$

14. Statistical Analysis

The data will be subjected to statistical analysis by adopting appropriate analysis of variance as described by Gomez and Gomez (1984). Wherever the F values found significant at 5 (%) level of probability and the critical difference (CD) values will be computed for making comparison among the treatment means. Pooled analysis will also be done for both the years.

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Signature of Student **Signature of Major Guide**

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